Polymers and Oligomers for Bulk Heterojunction Solar Cells: From Materials Design to Nanostructures Construction

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Polymer donor materials for bulk heterojunction (BHJ) organic solar cells (OSCs) should have low bandgap, low-lying HOMO level and high mobility. We synthesized a series of low bandgap donor-acceptor (D-A) conjugated polymers with isoindigo (IID) as A-unit and dithienocarbazole (DTC) or bithiophene as D-unit.[1-3] The OSCs based on polymers with DTC as D-unit exhibited power conversion efficiencies (PCEs) up to 8.2% although they are amorphous materials. When mono-fluorinated IID was used as A-unit, the resulting polymers could be processed with *o*-xylene as solvent, and OSCs with PCE of 7.5% were fabricated. The polymer based on mono-fluorinated IID and bithiophene has higher hole mobility. The OSCs fabricated with this polymer using *o*-xylene as solvent exhibited high PCE when the active layer thickness was varied in 105-340 nm.

Well-defined nanostructures are crucial for BHJ OSCs. We developed donor-spacer-acceptor (D-S-A) conjugated oligomers with perylene diimide (PDI) as A-unit, which can form D-A alternating lamellar nanostructures with periods of ~15 nm, an ideal nanostructure for BHJ OSCs.[4] The introduction of alkyl spacer between D- and A-units allows manipulating the exciton dissociation and geminate charge recombination processes, and a single-molecule OSC with a PCE of 2.70% has been fabricated.

References

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